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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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INVENTOR(S)

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Additional inventors are being named on the ______ separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max)

Siir's Photo-Acoustic Theory and Visual Orchestration Technology

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ENCLOSED APPLICATION PARTS *(check all that apply)*

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☐ Application Data Sheet, See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☒ Applicant claims small entity status. See 37 CFR 1.27.

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

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Date 8/18/2003

REGISTRATION NO. (if appropriate) ______

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

Patent Explanation

Siir's Photo-Acoustic Theory and Visual Orchestration Technology

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1. STATEMENT OF THE NEED f r THIS PATENT

1.1. Impact of Light and Sound: Light and sound have a compound impact on every phase of human experience. If they could be coupled by a seamless mathematical correlation in an innovatively engineered technology, then a new horizon in scientific knowledge can emerge and address universal needs. Colors could be heard and music could be seen in enhancing audio-visual cognition, treating the impaired, and [illegible] ls in art, science, and music.

In the human brain, the seven color response subfields are arranged from low frequency (red) to high frequency (violet). This i[illegible] ttern of a rainbow. Similarly, each subfield in the human brain for sound re[illegible] n low to high frequency. This indicates that there is a n[illegible] sequencing of light and sound waves. Until the finding of Siir's Photo-Acoustic Theory, this similarity could not be quantified on a <u>common ground</u> and utilized effectively by a mathematical correlation.

1.2. The Common Ground of Human Cognitive Functions:

Utilizing the Cognitive Structure of the Human Brain.

- Only with a robust correlation can the cognitive structure of the human brain be effectively utilized in an enhanced and controlled mode to coordinate, couple, integrate, and superimpose color and sound perception for constructive purposes.
- Siir's Photo-Acoustic Theory provides an unbiased and scientific correlation for the first time. This correlation also establishes a common ground to understand the parallelism in the cognitive structure, making it possible to simultaneously generate enhanced human color and sound perception.

1.3. Patent Targets: Music affects all human beings in many ways and develops cognitive functions associated with many intellectual abilities. Colors can be used to enrich the way our brain analyzes music because with Siir's Photo-Acoustic Theory, there is a direct

mathematical equation that correlates sound and light waves. The objective of this research is to engineer a Visual Orchestration Technology to colorize musical compositions arranged for the orchestra based on Siir's Photo-Acoustic Theory. By combining sound and color in orchestrations, both an event and color cognition will be simultaneously stimulated. By a dynamic mapping of this correlation to the instruments in an orchestra, a Visual Orchestration Technology will be obtained for the first time. These objectives can be identified in three major categories:

- Pioneer to investigate the practical feasibility of effectively utilizing the human color and sound cognitions based on Siir's Photo-Acoustic Theory.
- Develop a novel Visual Orchestration Technology for colorizing orchestral arrangements and demonstrate the validity of the project.
- Emerge a new horizon in the scientific knowledge base to address human needs ranging from music education to the treatment of cognitive deficiencies.

2. Explanation of Siir's Photo-Acoustic Theory

Several unsuccessful attempts have been made in the past to associate color and sound. Such as, Beethoven called B-minor the black key and Newton related the colors red, orange, and yellow to the major keys of C, D and E [1, 2]. A detailed literature survey was compiled as shown in Appendix A. In this research, Siir's Photo-Acoustic Theory found the missing Rosetta Stone between light and sound, bridging centuries' worth of efforts to correlate color and music [3]. For the first time, the Photo-Acoustic Theory revealed a direct and unique proportion between the wavelengths of visible light and audible sound that is seamless and continuous.

3. THEOREMS OF THE PATENT

Theorem One of Siir's Photo-Acoustic Theory established a unique Photo-Acoustic Number k from the ratios of light and sound wavelengths raised to a power with a proportionality constant, which is composed of a spectral color tone index r and a scaling factor a.

Theorem 1

$$\left(\frac{a}{r}\right)\frac{\lambda_s^{\,m}}{\lambda_p^{\,n}} = k \qquad (1)$$

According to k, the seven musical note sounds A through G associate with the sequence of the seven colors in a rainbow, and the wavelengths of spectral colors at every tone associate with a distinct sound wavelength in the audible range. k is proportional to the ratio between the speed of light and the speed of sound: $[4/3\times(c/v_s)]^{0.5}$. Theorem Two is an application of Theorem One by making the scaling factor a function of octaves in music O' using the golden ratio ϕ, which is recognized for giving harmony in the nature. It provides a mathematical equation that associates every note sound in all octaves with a unique spectral color wave at a distinct tone: tones of music associate with tones of colors.

Theorem 2

$$\frac{2^{\left(\frac{O'-4}{\sqrt{\phi}}\right)}}{2r}\sqrt[2]{\frac{\lambda_s}{\lambda_p}} = k \qquad \{0 \le O' \le 7, 0 < r < 1\} \qquad (2)$$

Theorem Three reflected a direct proportion between color tones and musical octaves. It also shows that the ratio of color tones of successive octaves is a constant.

Theorem 3

$$r = 2^{\left(\frac{O'-4}{2\sqrt{\pi}}-1\right)} \rightarrow \frac{r_{i+1}}{r_i} = 2^{\frac{1}{2\sqrt{\pi}}} \qquad \{i = 0, 1, 2, 3, \ldots 6\} \qquad (3)$$

Using The Photo-Acoustic Theory, the Acousto-Chromatic Diagram was developed by a plane laying process (see Appendix B). Each layer corresponds to an octave in music and its calculated color tone, and each note lines-up on the wavelengths of their corresponding color. The Acousto-Chromatic Diagram is the first successful superposition of audible sound on the entire color spectra, which is defined by the C.I.E. Color Chromaticity Diagram [4].

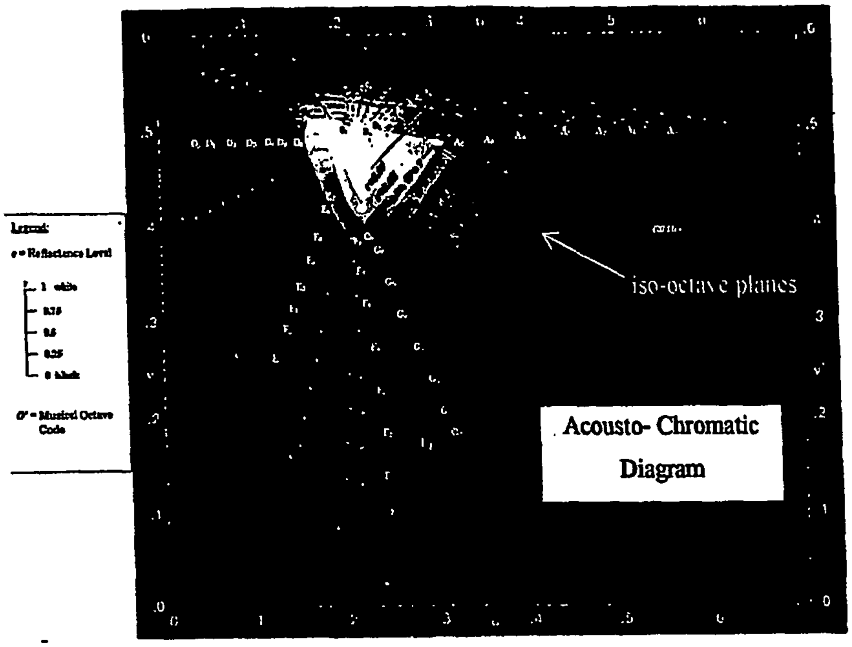


Figure 1. Acousto-Chromatic Diagram for the Entire Audible and Visible Range.

4. Procedure in Developing the Patent Subjects

4.1. Developing the Visual Orchestration Technology: Music Painter (*Color-Acoustics*):

A new Color-Midi Sequencing (CMIDI) algorithm establishes the dynamic mapping necessary for the Visual Orchestration Technology. Siir's Photo-Acoustic Theory is used to dynamically map each note played by every orchestral instrument for every time interval in a measure to the corresponding color and its distinct spectral color tone index defined by the reflectance level ***r*** in Theorems 2 and 3. The time intervals of each note are calculated by knowing the general tempo of the musical composition because every note value is associated with a fraction of this general tempo. This mathematical procedure has three main steps:

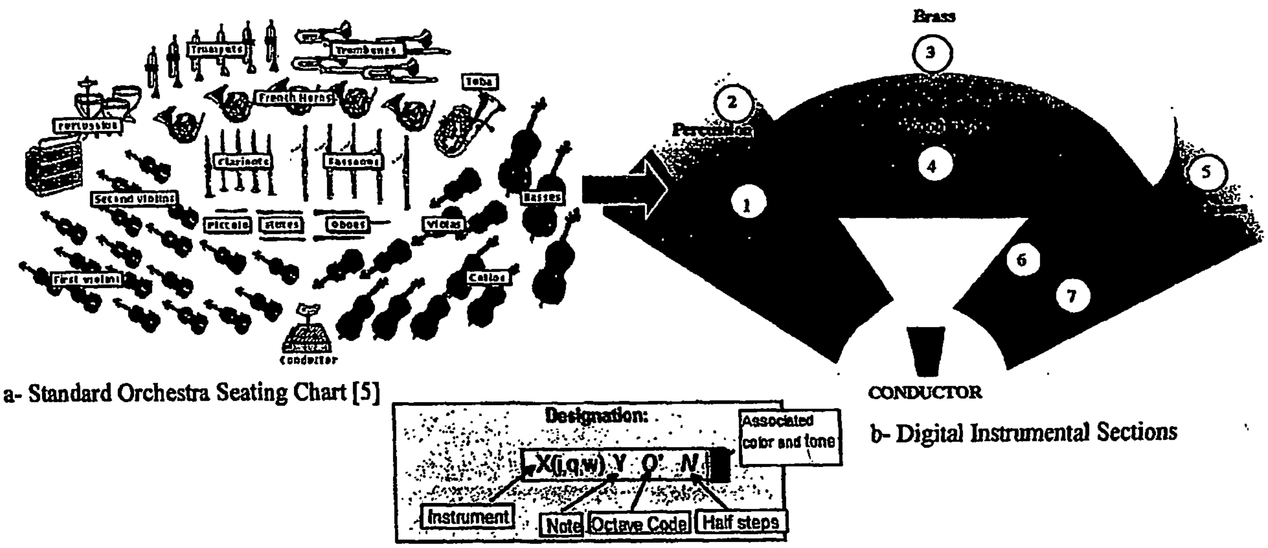
Step 1- develop a digital simulation of the standard orchestra seating,

Step 2- develop a Color-Midi Sequencing of a given music composition,

Step 3- dynamically transform the Color-Midi Sequence to the orchestral instruments.

<u>**Step 1:**</u> The main orchestral sections on a standard seating chart [5] (Figure 2-a) were numerically identified with numbers 1 to 7 (Figure 2-b). Each section may also have subsections. Therefore,

each instrument X is identified by a three number system X (j, q, w). j is the section number, q is the subsection number, and w is the instrument number in that section (Figure 2-c) .



a- Standard Orchestra Seating Chart [5]

b- Digital Instrumental Sections

c- New CMIDI Identification System.

Figure 2. New CMIDI Identification System of the Orchestral Instruments and the Music

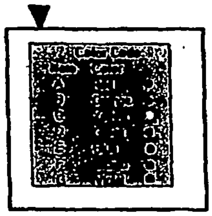
Step 2: A Color-Midi Sequencing algorithm (CMIDI) was developed. The CMIDI file contains data about the instrument X (j, q, w), the note that it played Y, the octave code *O'* that the played note is in, and the number of half steps *N*, which is the smallest interval between successive notes. Knowing the *O'* and *N*, the corresponding color and its reflectance level are calculated as exemplified in Table 1 for the 52 white piano keys [6,7]. This table provides a visual perception of musical sounds, which may be used to treat tonal deafness and train for perfect pitch [8].

Step 3: In Step 3, the Color-Midi File is graphically transformed by mapping the color values on the orchestra-seating chart on a real time basis. In summary, Figure 4 shows how the Visual Orchestration Technology will transform music to color on the orchestra-seating plan. This algorithm is further described in Figures 5 and 6. Ten sample frames are given in Appendix C.

Table 1 .Color-Sound Association Using Siir's Photo-Acoustic Theory for White Piano Key Sounds in air at 25°C.

WHITE PIANO KEYS					COLORS				SOUNDS
Octave	Octave code	Key note	Note code	Color	#halfsteps	Wavelength	Reflectance	Color	Note sound Wavelength
O	O'	letter	Z		N	λ_p (m)	r		λ_s (m)
0	0	A	0	red	-48	6.80E-07	2.27E-01		1.26E+01
0	0	B	1	orange	-46	5.95E-07	2.267E-01		1.12E+01
1	0	C	2	yellow	-45	5.75E-07	2.267E-01		1.06E+01
1	0	D	3	green	-43	5.10E-07	2.272E-01		9.43E+00
1	0	E	4	blue	-41	4.75E-07	2.222E-01		8.40E+00
1	0	F	5	indigo	-40	4.45E-07	2.230E-01		7.93E+00
1	0	G	6	violet	-38	3.85E-07	2.263E-01		7.06E+00
1	1	A	0	red	-36	6.80E-07	2.772E-01		6.29E+00
1	1	B	1	orange	-34	5.95E-07	2.797E-01		5.60E+00
2	1	C	2	yellow	-33	5.75E-07	2.764E-01		5.29E+00
2	1	D	3	green	-31	5.10E-07	2.770E-01		4.71E+00
2	1	E	4	blue	-29	4.75E-07	2.709E-01		4.20E+00
2	1	F	5	indigo	-28	4.45E-07	2.72E-01		3.96E+00
2	1	G	6	violet	-26	3.85E-07	2.760E-01		3.53E+00
2	2	A	0	red	-24	6.80E-07	3.380E-01		3.15E+00
2	2	B	1	orange	-22	5.95E-07	3.41E-01		2.80E+00
3	2	C	2	yellow	-21	5.75E-07	3.370E-01		2.65E+00
3	2	D	3	green	-19	5.10E-07	3.378E-01		2.36E+00
3	2	E	4	blue	-17	4.75E-07	3.304E-01		2.10E+00
3	2	F	5	indigo	-16	4.45E-07	3.316E-01		1.98E+00
3	2	G	6	violet	-14	3.85E-07	3.365E-01		1.77E+00
3	3	A	0	red	-12	6.80E-07	4.121E-01		1.57E+00
3	3	B	1	orange	-10	5.95E-07	4.159E-01		1.40E+00
4	3	C	2	yellow	-9	5.75E-07	4.110E-01		1.32E+00
4	3	D	3	green	-7	5.10E-07	4.119E-01		1.18E+00
4	3	E	4	blue	-5	4.75E-07	4.029E-01		1.05E+00
4	3	F	5	indigo	-4	4.45E-07	4.044E-01		9.91E-01
4	3	G	6	violet	-2	3.85E-07	4.103E-01		8.83E-01
4	4	A	0	red	0	6.80E-07	5.026E-01		7.86E-01
4	4	B	1	orange	2	5.95E-07	5.071E-01		7.01E-01
5	4	C	2	yellow	3	5.75E-07	5.012E-01		6.61E-01
5	4	D	3	green	5	5.10E-07	5.023E-01		5.89E-01
5	4	E	4	blue	7	4.75E-07	4.912E-01		5.25E-01
5	4	F	5	indigo	8	4.45E-07	4.931E-01		4.95E-01
5	4	G	6	violet	10	3.85E-07	5.004E-01		4.41E-01
5	5	A	0	red	12	6.80E-07	6.128E-01		3.93E-01
5	5	B	1	orange	14	5.95E-07	6.184E-01		3.50E-01
6	5	C	2	yellow	15	5.75E-07	6.111E-01		3.31E-01
6	5	D	3	green	17	5.10E-07	6.125E-01		2.95E-01
6	5	E	4	blue	19	4.75E-07	5.990E-01		2.62E-01
6	5	F	5	indigo	20	4.45E-07	6.013E-01		2.48E-01
6	5	G	6	violet	22	3.85E-07	6.101E-01		2.21E-01
6	6	A	0	red	24	6.80E-07	7.473E-01		1.97E-01
6	6	B	1	orange	26	5.95E-07	7.540E-01		1.75E-01
7	6	C	2	yellow	27	5.75E-07	7.452E-01		1.65E-01
7	6	D	3	green	29	5.10E-07	7.468E-01		1.47E-01
7	6	E	4	blue	31	4.75E-07	7.304E-01		1.31E-01
7	6	F	5	indigo	32	4.45E-07	7.332E-01		1.24E-01
7	6	G	6	violet	34	3.85E-07	7.440E-01		1.10E-01
7	7	A	0	red	36	6.80E-07	9.112E-01		9.83E-02
7	7	B	1	orange	38	5.95E-07	9.195E-01		8.76E-02
8	7	C	2	yellow	39	5.75E-07	9.087E-01		8.27E-02

$$r = \frac{2^{\left(\frac{O'}{\sqrt{\phi}} - \frac{N}{24}\left(\frac{4}{\sqrt{\phi}}+1\right)\right)}}{k\sqrt{\lambda_p}} \times \sqrt[2]{\frac{v_s}{440}}$$



4.2. Sensitivity Analysis: In an orchestral performance, the ambient temperature changes the sound wavelength of the notes played. The sensitivity of the Photo-Acoustic Number k on the ambient air temperature T_a was analyzed to show that this sensitivity compensates for the changes in the ambient temperature [3]. Because the speed of sound is a function of T_a, k is also a function of T_a [3, 9]:

$$k(T_a) \approx 1.07 \times 10^3 (T_a/298)^{0.25} \quad . \qquad \{0°C \leq T_a \leq 45°C\} \qquad (4)$$

The maximum change of k with T_a is shown in Figure 4 between 0°C and 45°C for note keys A, B, and F in the middle octave (colors R, O, I). The sensitivity of k on note keys in a given octave $\Delta k/\Delta Z$ is ± 1%. Therefore based on k, the Color-Midi Sequencing can adjust the mathematical color-sound correlation accordingly, such that the simulation will be accurate within the instrument's sound variations as a function of the ambient temperature.

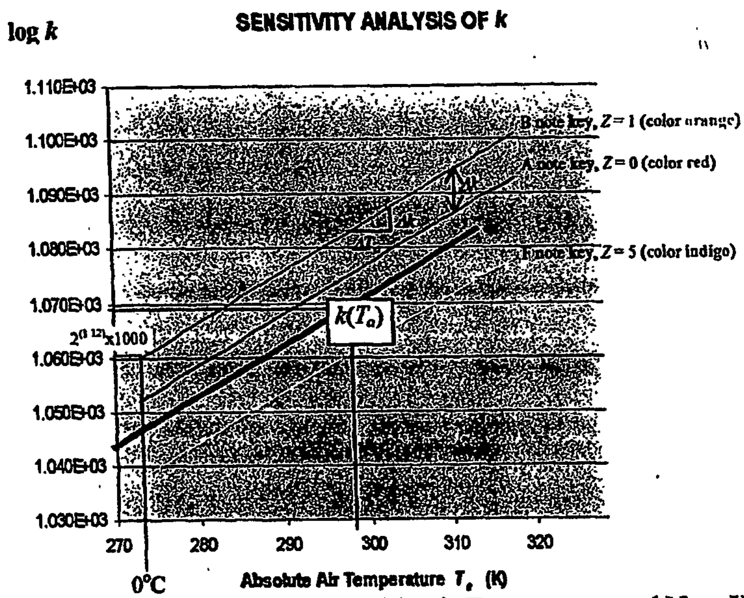


Figure 3. Change of Photo-Acoustic Number with Air Temperature and Note Keys ($O' = 4$).

The human ear is sensitive to 1 Hz, and the eye is sensitive to a light wavelength of 5 nm. The composite maximum sensitivity ratio is ½(1/440 Hz/Hz + 5/680 nm/nm) = 4.81×10^{-3}, which can be distinguished by the Photo-Acoustic Theory. Therefore, the Photo-Acoustic Theory provides an analytical tool for an accurate and precise coupling of the human auditory and visual perception.

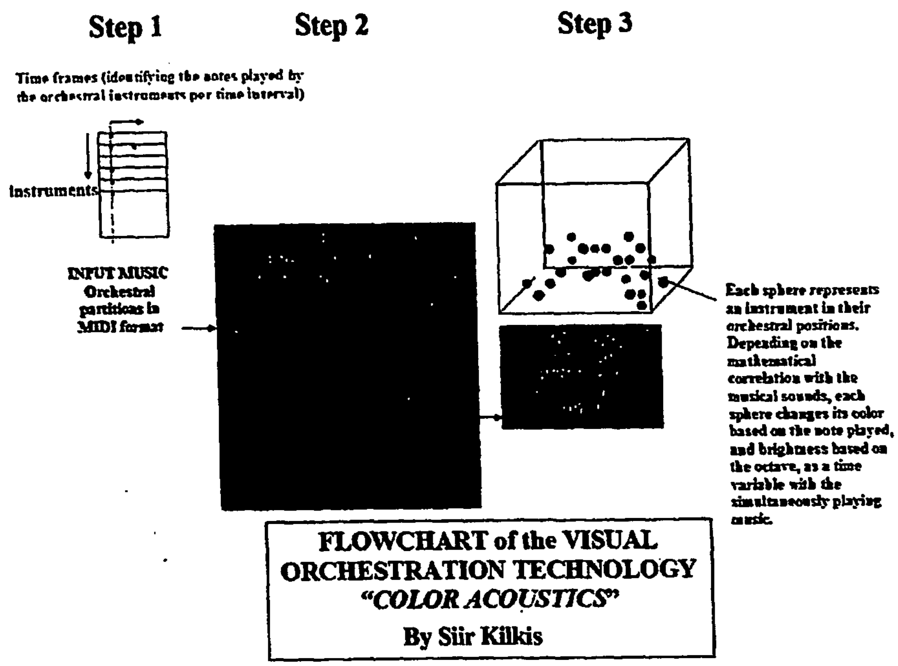


Figure 4. Mathematical Steps of the Visual Orchestration Technology: Music Painter (*Color-Acoustics*).

5. SAMPLE APPLICATIONS of the PATENT

5.1. Application of the Visual Orchestration Technology- *Music Painter*: The Visual Orchestration Technology was an inspiration from Siir's musical composition titled "Our World is a Kaleidoscope." Like the myriads of colors in a kaleidoscope, the instruments in an orchestra create a mosaic of sounds. The Visual Orchestration Technology captures this mosaic of sounds with colors. Because the Acousto-Chromatic Diagram covers the entire audible range, all the instruments in an orchestra can be colorized.

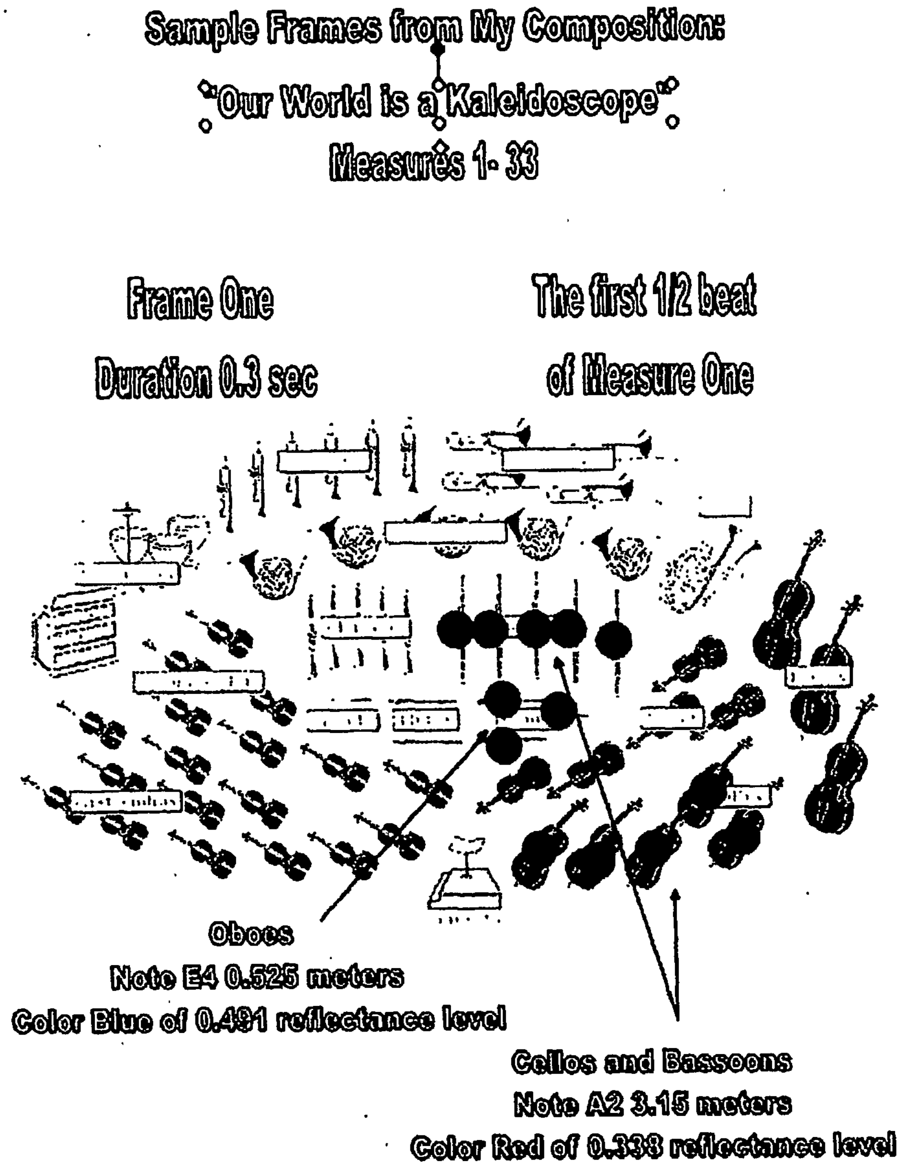


Figure 5. Sample Orchestration Frame for the Composition "Our World is a Kaleidoscope:"

Frame 1.

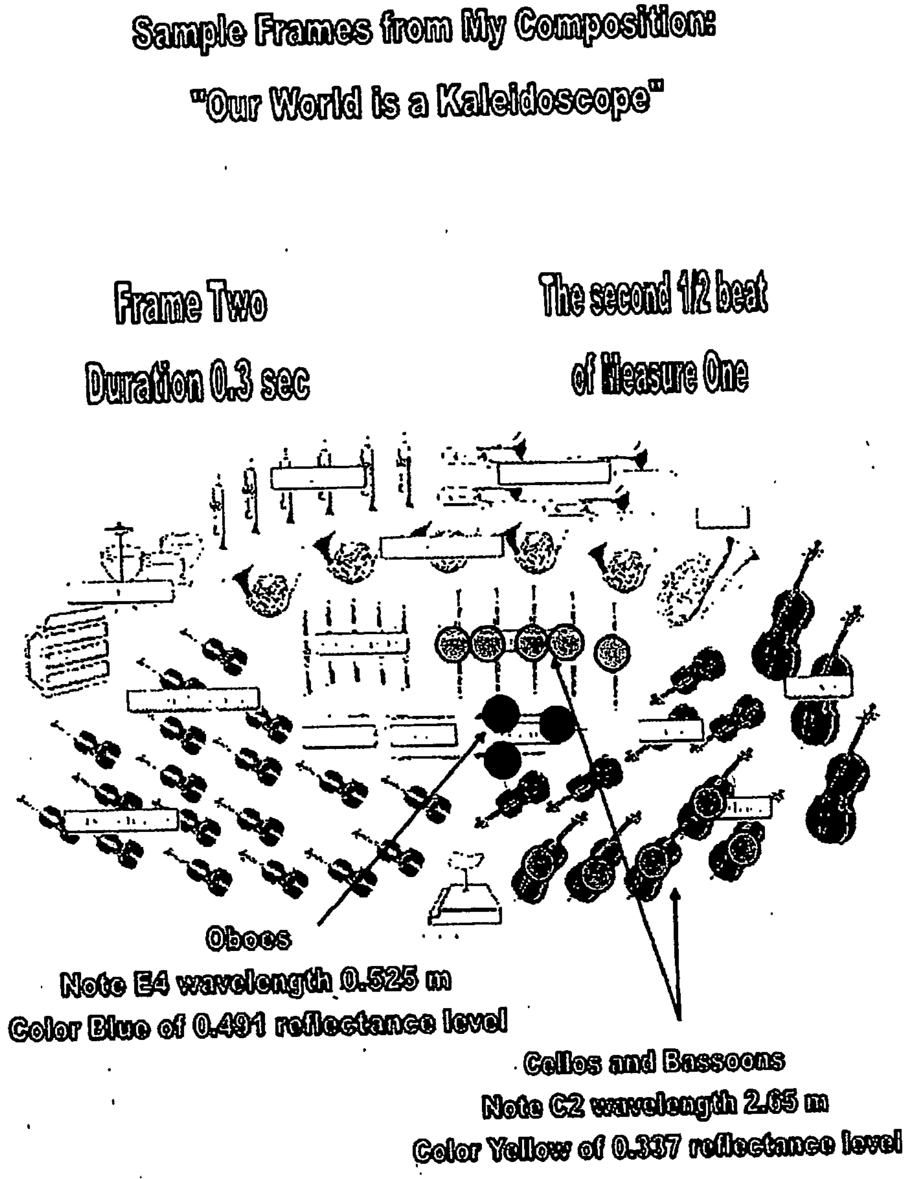


Figure 6. Sample Orchestration Frame for the Composition "Our World is a Kaleidoscope:"

Frame 2.

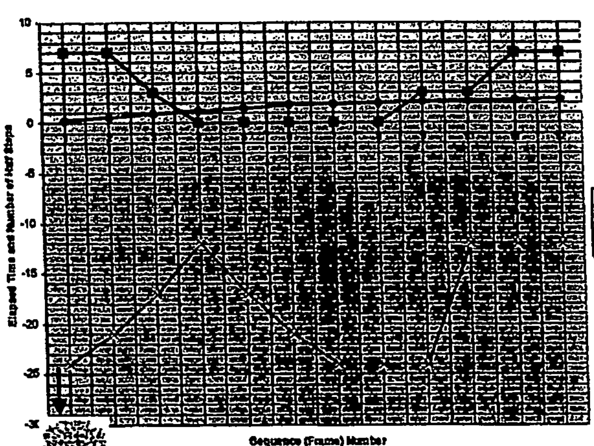
The Color-Midi Sequencing (CMIDI) algorithm developed in this research is further detailed in Figure 7-a, as shown for the measures five, six, and seven sampled from the orchestration score of "Our World is a Kaleidoscope" at a general tempo of 100 beats per minute. Dynamics of the CMIDI is also shown graphically for measures one and two as shown in Figure 7-b. Measure one starts with two woodwinds and the cello. At the first time increment (frame), the oboe plays the note E in the 4^{th} octave code, which is 7 half steps above the note A in the middle octave, corresponding to the color blue and its calculated reflectance level from Theorem 2 as shown in Table 1. The bassoon and cello are in unison and play note A in the second octave code, which is 24 half steps below note A in the middle octave, corresponding to dark red with a reflectance level of 0.33. The next event is after 0.3 seconds. Towards the end of measure one, the time increments are 0.1 seconds indicating that faster rhythms are being played. The graphs show all the information recorded from the Color-Midi Sequencing. Each data point corresponds to one frame for the visual orchestration as shown in the inset of the first graph.

When all the frames are dynamically mapped on the computer screen while the music is simultaneously playing, a color-sound combined orchestra performance is generated on a real-time basis. The twelve individual frames, which correspond to the dynamic mapping of the first measure of "Our World is a Kaleidoscope", are shown in Figure 8. These frames are animated on the computer screen with exactly the same time intervals of the musical notes played. This effect combines the color and sound cognition.

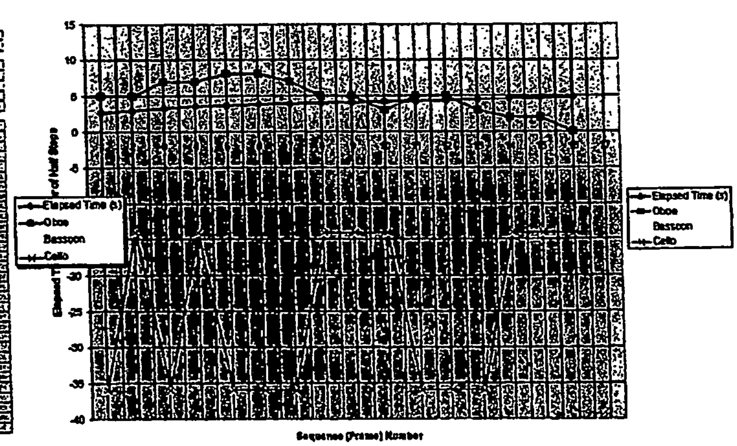
											Measure 5 begins							
51	0.3	9.9	O(4.3.3)	C	4	3	C(4.4.5)	C	4	3	B(4.5.5)	F	1	-28	Ce(7.1.5)	F	1	-28
52	0 3	10.2	O(4.3.3)	C	4	3					B(4.5.5)	A	2	-24	Ce(7.1.5)	A	2	-24
53	0.3	10.5	O(4.3.3)	A	4	0					B(4.5.5)	C	2	-21	Ce(7.1.5)	C	2	-21
54	0 3	10.8	O(4.3.3)	F	3	-4					B(4.5.5)	F	2	-16	Ce(7.1.5)	F	2	-16
55	0.15	10 95	O(4.3.3)	F	3	-4					B(4.5.5)	C	2	-21	Ce(7.1.5)	C	2	-21
56	0 15	11.1	O(4.3.3)	F	3	-4					B(4.5.5)	A	2	-24	Ce(7.1.5)	A	2	-24
57	0.15	11 25	O(4.3.3)	F	3	-4					B(4.5.5)	F	1	-28	Ce(7.1.5)	F	1	-28
58	0.15	11.4	O(4.3.3)	F	3	-4					B(4.5.5)	F	1	-28	Ce(7.1.5)	F	1	-28
59	0.15	11.55	O(4.3.3)	A	4	0					B(4.5.5)	F	1	-28	Ce(7.1.5)	F	1	-28
60	0.15	11.7	O(4.3.3)	A	4	0					B(4.5.5)	F	2	-16	Ce(7.1.5)	F	2	-16
61	0.15	11 85	O(4.3.3)	C	4	3					B(4.5.5)	F	2	-16	Ce(7.1.5)	F	2	-16
62	0.15	12	O(4.3.3)	C	4	3					B(4.5.5)	F	2	-16	Ce(7.1.5)	F	2	-16
											Measure 6 begins							
63	0 3	12.3	O(4.3.3)	B	4	2					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
64	0 3	12.6	O(4.3.3)	B	4	2					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
65	0 3	12.9	O(4.3.3)	C	4	3					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
66	0.3	13.2	O(4.3.3)	C	4	3					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
67	0.15	13.35	O(4.3.3)	D	4	5					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
68	0.15	13.5	O(4.3.3)	C	4	3					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
69	0.15	13.65	O(4.3.3)	B	4	2					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
70	0.15	13.8	O(4.3.3)	A	4	0					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
71	0.15	13.95	O(4.3.3)	B	4	2					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
72	0.15	14.1	O(4.3.3)	A	4	0					B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
73	0.15	14.25	O(4.3.3)	G	3	-2					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
74	0 15	14.4	O(4.3.3)	F	3	-4					B(4.5.5)	E	2	-17	Ce(7.1.5)	E	2	-17
											Measure 7 begins							
75	0.9	15.3	F(4.2.2)	B	4	2	O(4.3.3)	B	4	2	B(4.5.5)	E	1	-29	Ce(7.1.5)	E	1	-29
76	0.9	16.2	F(4.2.2)	C	4	3	O(4.3.3)	C	4	3	B(4.5.5)	F	1	-28	Ce(7.1.5)	F	1	-28
77	0.6	16.8	F(4.2.2)	D	4	5	O(4.3.3)	D	4	5	B(4.5.5)	G	1	-26	Ce(7.1.5)	G	1	-26
											Measure 8 begins							
78	0.6	17.4	F(4.2.2)	E	4	7	O(4.3.3)	E	4	7	B(4.5.5)	A .	2	-24	Ce(7.1.5)	A	3	-12
79	0.3.	17.7	F(4.2.2)	E	4	7	O(4.3.3)	E	4	7	B(4.5.5)	A	2	-24	Ce(7.1.5)			
80	0.1	17.8	F(4.2.2)	F	4	8	O(4.3.3)	F	4	8					Ce(7.1.5)			
81	0.1	17.9	F(4.2.2)	E	4	7	O(4.3.3)	E	4	7					Ce(7.1.5)			
82	0.1	18	F(4.2.2)	D	4	5	O(4.3.3)	D	4	5					Ce(7.1.5)			
83	0.3	18.3	F(4.2.2)	E	4	7	O(4.3.3)	E	4	7	B(4.5.5)	A	2	-24	Ce(7.1.5)			
84	0.3	18.6	F(4.2.2)	E	4	7	O(4.3.3)	E	4	7	B(4.5.5)	E	2	-17	Ce(7.1.5)			

Figure 7-a. CMIDI Data for the three measures of "Our World is a Kaleidoscope."

COLOR-MIDI SEQUENCING for SAMPLE ONE, MEASURE ONE



COLOR-MIDI SEQUENCING for SAMPLE ONE, MEASURE TWO



Frame 1

Figure 7-b. Graphical Representation of CMIDI Data for Measures one and two for "Our World is a Kaleidoscope."

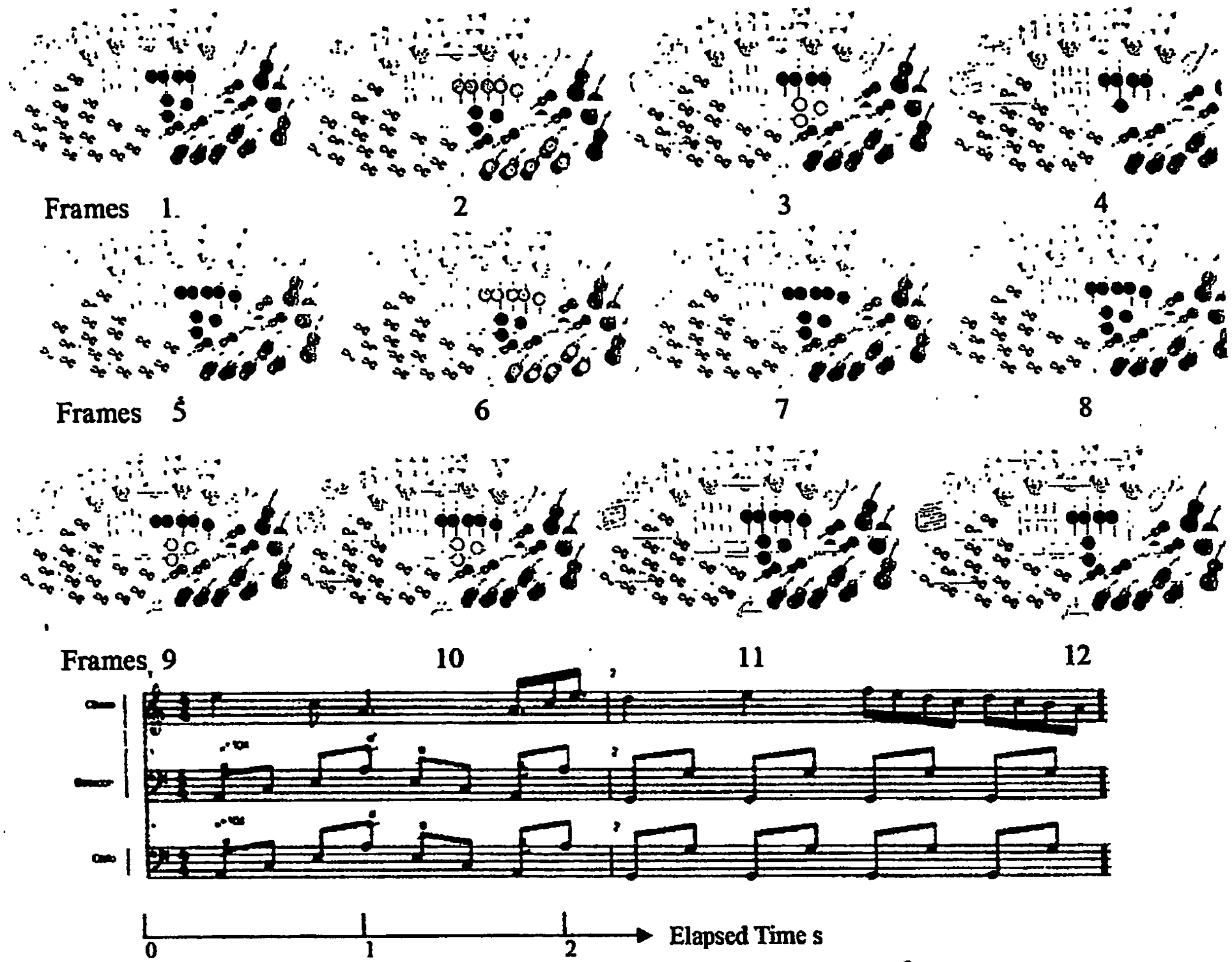


Figure 8. Real-Time Color-Midi Sequence Frames for the First Measure of "Our World is a Kaleidoscope."

5.2. Composing an Artwork: *Art Composer*

When the Visual Orchestration Technology "Music Painter" is reverse engineered, it becomes an "Art Composer." In this case, it becomes possible to compose music for a given artwork by using Siir's Photo-Acoustic Theory. For this purpose, the artwork needs to be discretized into small fragments (grids). The discretization grid has two dimensions. First one is the time frame that musical notes corresponding to the color in that art fragment plays. The second dimension is the instrument in the orchestra, which plays that art frame. This algorithm is shown in Figure 9.

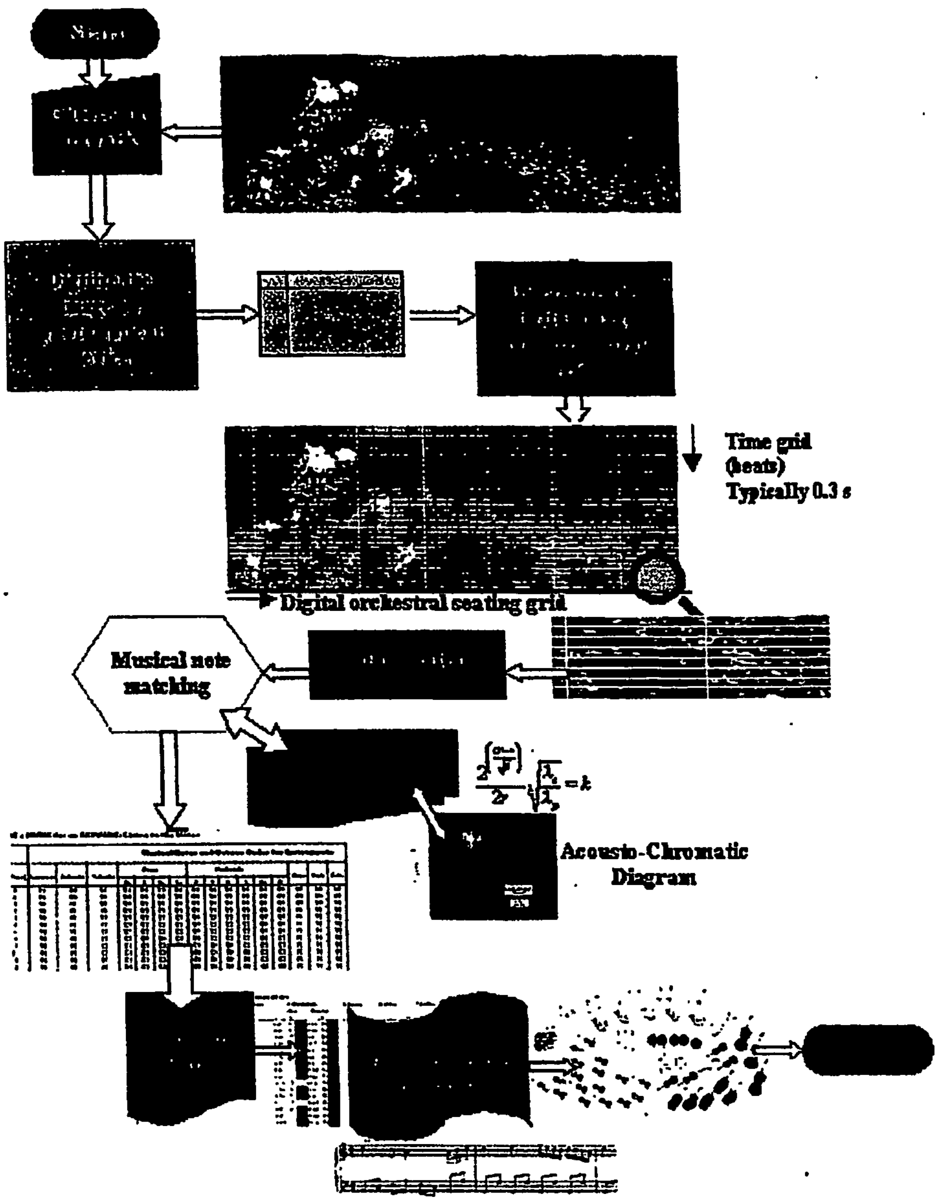
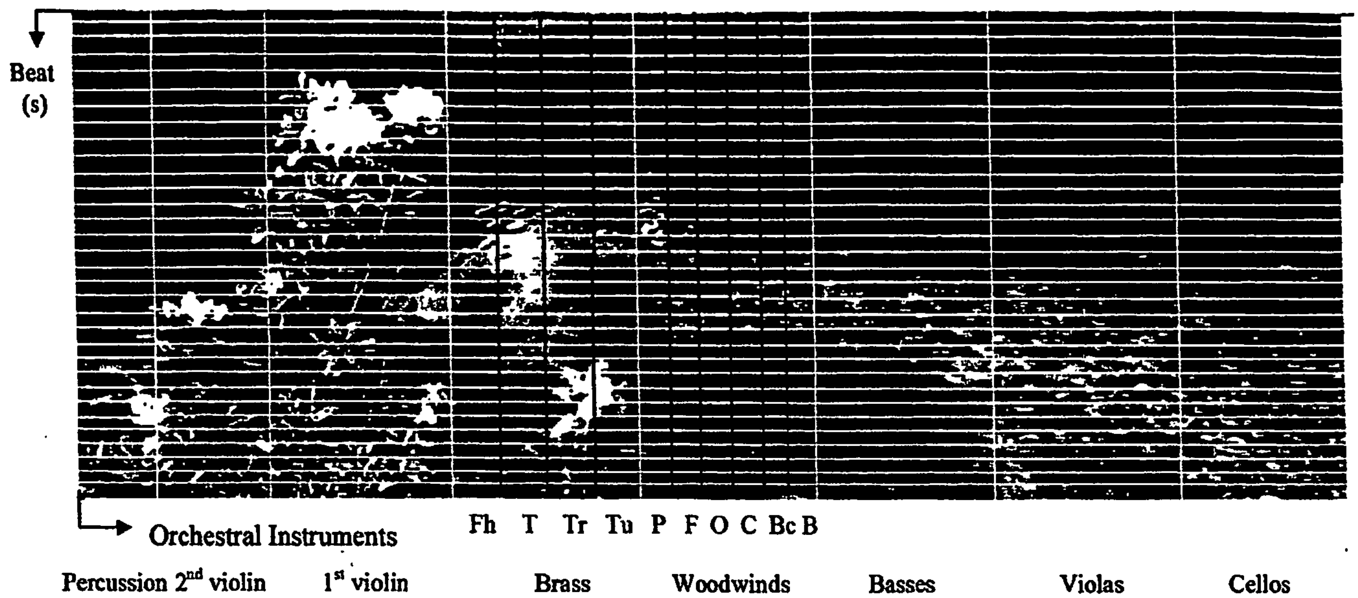


Figure 9. Algorithm of the Art Composer.

5.3. Example to Art Composer "Listen to the Water."

As an example, a picture of a lake was composed with the Art Composer. Discretization of this picture into grids is described in Figure 10. The MIDI sequencing sample is shown in Table 2. The entire music composition "Listen to the Water" is given in Appendix D.



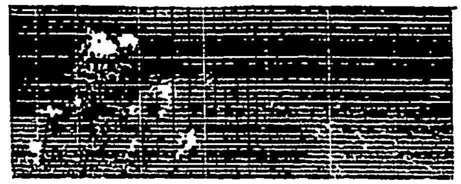
Key to instruments:
Fh French horn
T Trumpet
Tr Trombone
Tu Tuba
P Piccolo
F Flute
O Oboe
C Clarinet
Bc Bass clarinet

Figure 10. Dynamic Orchestration Grid using the Art Composer for Listen to the Water."

Each grid element is analyzed for its dominant color, and the corresponding sound is determined using Siir's Photo-Acoustic Theory. This data is first converted into a music file (Table 2) and then the musical notation is made to orchestrate the artwork (Appendix D).

Table 2. Sample Music File for "Listen to the Water."

Picture



Dynamic Orchestration Grid

COMPOSING a MUSIC for an ARTWORK: Listen to the Water

Time		Musical Notes and Octave Codes for Instruments															
Beat (0.3 s)	Cum.Time (s)	Percussion	2nd violin	1st violin	Brass				Woodwinds						Bass	Viola	Cello
					Fh	T	Tr	Tu	P	F	O	C	Bc	B			
1	0.3	E5	E4	E4	E4	E5	E3	E4	E4	E3	E4	E4	E4	E4	D0	B0	B0
2	0.6	E5	E4	E4	E4	E5	E5	E4	E4	E4	E5	E5	E5	E5	E5	E4	B0
3	0.9	F0	F0	E0	E4	E5	E5	E4	E5	E5	E4	E4	E4	E4	E4	E3	F0
4	1.2	F0	F0	F0	E3	E5	E5	E5	E4	E5	E5	E5	E4	E4	F4	F3	F0
5	1.5	F0	F0	F1	E3	E5	E5	E5	E4	E5	E5	E5	E4	E4	F4	F3	F0
6	1.8	F0	F0	C7	E3	E5	E5	E5	E4	E5	E5	E5	E4	E4	F4	F2	F0
7	2.1	F0	F0	C7	E2	E5	E5	E5	E4	E5	E5	E5	E4	E4	F3	F1	F0
8	2.4	F0	F0	C7	E2	E4	E4	E4	E4	E5	E5	E5	E4	E3	F2	F1	F0
9	2.7	F0	F0	C7	E1	E1	E3	E4	E4	E4	E4	E4	E3	E3	F2	F1	F0
10	3	F0	F0	C7	E1	E1	E3	E4	E4	E4	E4	E4	E3	E3	F2	F1	F0
11	3.3	F0	F0	D7	E1	E1	E3	E4	E4	E4	E4	E4	E3	E3	F3	F1	F0
12	3.6	F0	F0	D7	E1	E1	E3	E4	E4	E4	E4	E4	E3	E3	F3	F1	F0
13	3.9	F0	F2	D7	E6	E4	E3	E4	E3	E4	E4	E4	E3	E3	F3	F1	F0
14	4.2	F0	F4	D6	E6	E5	E5	E5	E4	E4	E4	E4	E3	E3	F3	F1	F0
15	4.5	F0	F4	D6	E6	E6	E6	E5	E4	E4	E4	E4	E4	E4	F3	F3	F2
16	4.8	F0	F4	D6	E6	E6	E6	E5	E4	E4	E4	E4	E4	E4	F3	F3	F2
17	5.1	F0	F3	D4	E6	E6	E6	E5	E4	E5	E5	E5	E5	E5	E4	F3	F3
18	5.4	F2	F5	D4	E4	E6	E6	E4	E4	E5	E5	E5	E5	E5	E4	F5	B0
19	5.7	F3	C7	D3	E4	E6	E6	E4	E4	E5	E5	E5	E5	E5	E4	F6	B0
20	6	E5	C7	B3	E4	E6	E6	E4	E4	E4	E5	E5	E5	E5	E5	E3	B0
21	6.3	E5	D4	B3	E4	E6	E6	E4	E4	E5	E5	E5	E4	E5	E5	E3	B1
22	6.6	E5	D4	B3	E4	E6	E6	E4	E4	E5	E5	E5	E4	E5	E5	E3	B1
23	6.9	E5	D4	B3	E4	E6	E6	E4	E4	E5	E5	E5	E4	E5	E5	E3	B2
24	7.2	E5	D4	B3	E4	E6	E6	E4	E4	E5	E5	E5	E4	E5	E5	E3	B3
25	7.5	E6	E5	B3	E4	E6	C7	C7	E4	E5	E5	E5	E4	E5	E5	E5	B3
26	7.8	E6	E5	B3	E4	E6	C7	C7	E4	E5	E5	E5	E4	E5	E4	E5	B3
27	8.1	E6	E5	B3	E4	E6	C7	C7	E4	E5	E5	E5	E4	E5	E4	E5	B3
28	8.4	B2	F5	B3	E4	E6	C7	C7	E4	E5	E5	E5	E4	E5	E4	E5	E5
29	8.7	B2	D2	B3	E4	E6	C7	C7	E4	E5	E5	E5	E4	E5	E4	E5	E5
30	9	F6	D1	D3	E4	E5	D3	B4	E4	E4	E4	E4	E4	E4	E5	E6	E6
31	9.3	D5	D1	D3	E4	D4	D3	B4	E4	E4	E4	E4	E4	E4	E5	E6	E6
32	9.6	F1	D1	D3	E4	D4	D3	B4	E4	E4	E4	E4	E4	E4	E5	E6	E6

6. MORE THEORY

As a theoretical extension, the Photo-Acoustic Number k was substituted into Brillouin's acousto-optical effect, contributing to science with additional three non-dimensional numbers.

6.1. Acousto-Optic Number k': According to the acousto-optical effect, which was first noted by Brillouin [10], a light wave shifts its frequency upon interacting with a sound wave:

$$\Delta f_p/f_p = \pm(v_s/c)\sin\theta/2 \quad . \quad \{\sin\theta/2 \approx \theta/2 = \lambda_p/2\lambda_s\} \quad (5)$$

Using the Photo-Acoustic Theory, $\sin\theta$ may now be eliminated by noting that

$$\lambda_s/\lambda_p \approx 4/3(c/v_s) \quad , \qquad (6)$$

$$\frac{\Delta f_p}{f_p} = \tfrac{3}{8}\left(\frac{v_s}{c}\right)^2 = \tfrac{2}{3}k^{-4} = k' \quad . \qquad \{v_s \propto \sqrt{T_a}\} \tag{7}$$

6.2. Thermo-Optic Number k_t: From the temperature dependence of the speed of sound v_s [9], Equation 7 can be bridged to optics with a new *Thermo-Optic Number* k_t, which is significant in thermo-optics for modulating light with the combination of sound and heat.

$$\frac{\Delta f_p}{f_p} = \tfrac{3}{8}\left(\frac{346}{c}\right)^2 \times \left(1 - \frac{\Delta T_a}{298}\right) = k_t \tag{8}$$

6.3. Simulation Number Ω_{ps}: Re-arranging Equation 6 in terms of sound and light wave frequencies and by multiplying the denominator and the numerator by Planck's constant h gives Corollary 1 of Theorem 1:

Corollary 1

$$\frac{hf_p}{hf_s} = \frac{e_p}{e_s} = \tfrac{4}{3}\left(\frac{c}{v_s}\right)^2 = \Omega_{ps} \quad . \tag{9}$$

"Sound and light energies may be simulated by a constant ratio, Ω_{ps} at given ambient conditions"

Equation 9 provides a robust simulation number to simulate a sound wave with an analog light wave whose energy is related by Ω_{ps}. In practice, this makes the design and analysis of acoustic chambers and modulators more efficiently.

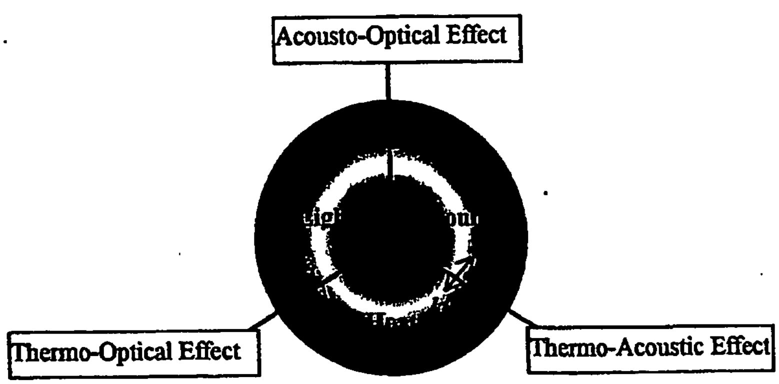


Figure 10. Light, Sound, and Heat Rosetta Stone based on Siir's Photo-Acoustic Theory [3].

7. DISCUSSION ABOUT The PATENT

7.1. The Harmony of Color and Sound in the Visual Orchestration Technology

- In "Our World is a Kaleidoscope," several motifs of sounds revealed the repeating visual patterns of red and blue, violet and green, indigo and yellow. The music composition also displayed a wide array of other satisfying color combinations.
- "The Reflections of the Lake" demonstrated the common ground in color and sound provided by Siir's Photo-Acoustic Theory. The tones of color correlated to tones of sound from the bold reflection of a mountain to the tingling reflection of the sky.
- The crossroads of the harmony of colors and sounds with the Visual Orchestration Technology sheds light to composing artwork with music and painting music with colors.

At a time when medical researchers are beginning to discover how the brain classifies and interprets color and sound, the Visual Orchestration Technology recognizes the biological patterns of audible sound and visible light based on Siir's Photo-Acoustic Theory. The principles of the Visual Orchestration Technology enhances the overall perception of simultaneous event and object cognition in the human brain because the brain regions of the color responses follow the same color sequence given in a rainbow [11], as also depicted by Siir's Photo-Acoustic Theory. According to another study, each subfield in the brain for sound responses is arranged from low frequency to high frequency starting from the posterior to anterior [12]. This study confirms that the dynamic color-sound sequencing engineered in the Visual Orchestration Technology corresponds to the human biological sequencing pattern. Therefore, it is concluded that the Visual Orchestration Technology emerges as a new scientific horizon in implementing creative devices by acousto-optical modulation with an accurate coupling of the human auditory and visual perception. The Visual Orchestration Technology is the first to colorize orchestral

arrangements, constructively coordinate color and sound stimuli for composers, conductors, and the impaired, and translate the Midi Sequence of an orchestral score into a new Color-Midi Sequence. This new technology has the following attributes:

- A cognitive color-sound association was achieved for the simultaneous colorizing of music with a new Color-Midi Sequencing algorithm.
- This algorithm is based on the Photo-Acoustic Theory, which precisely and accurately simulates the human cognition and seamlessly couples them.
- This algorithm is instrumental in enhancing the harmonization of music compositions, and combining event and object cognition in music.

Colorizing an orchestral arrangement with its instrumental partitions has the following benefits:

- The visual patterns can be used in music analysis and interpretation.
- The melodies and harmonies can be distributed to a composition by visualizing color.
- Conductors can identify dependent and independent parts through color duplications or differences.
- Orchestral intonation and performance can be improved by understanding the relationships and relativity between instrumental parts through color.
- Children can visually learn to associate the events of individual instrumental sections.
- Cognitive analysis of an orchestration or an orchestral composition can be enhanced with the coupling of note sounds and colors.
- Orchestral compositions can be written by hearing deficient individuals like Beethoven using color associations.
- Visual artworks may be enhanced through music by the reverse engineering applications.

7.2. More Sample Applications of the Patent

The Visual Orchestration Technology can be used in bioengineering applications, such as therapies for the visually and/or the hearing impaired. The Visual Orchestration Technology can also contribute to the development of a better and non-invasive hearing video for the visually impaired. By using the dynamic color-sound correlation technology, color video signals can be transmitted through auditory nerves.

Synthetic Synesthesia is a neuro-psychological phenomenon where two senses mix information. In a color-sound synesthesia, colored flashes may be "seen" when a telephone rings or is being dialed. The Visual Orchestration Technology can generate sound waves that will counter these false color signals, which can then be electronically transmitted through the ear.

Congenital Amusia is a music specific disorder, commonly known as tone deafness [13]. Because the Visual Orchestration Technology associates sound waves and visible colors, this disorder can be effectively treated by appealing to visual perception and its coupling to pitch.

8. REFERENCES of the PATENT

1- Birren, F., 1950. Color Psychology and Color Therapy: a Factual Study of the Influence of Color on Human Life, McGraw-Hill, NY (Print on demand, Pond View Books).

2- Newton, I., 1730. Optiks, Reprinted by Dover Publications, NY, 1952.

3- Kilkis, Siir. "Part I." My private diary.

4- C.I.E., 1976. U.C.S. Chromaticity Diagram. Int. Commission on Illumination, Vienna.

5- Encarta Reference Library 2003, <http://encarta.msn.com>

6- Kilkis, Siir. "Part II." My private diary.

7- Kilkis, Siir. "Part III." My private diary.

8- Kilkis, Siir. "Part IV." My private diary.

9- Bueche, J. F. and Hecht, E. Schaum's Outline of Theory and Problems of College Physics, 9th ed., McGraw-Hill, NY, 1997.

10- Brillouin, L. Ann. Phys. (17): 88, 1922.

11- Xiao, Y., Y. Wang, and D. J. Felleman, "A Spatially Organized Representation of Color in Macaque Cortical Area V2." Nature (421): 535-539, 2003.

12- Ong, W. J. "World as View and World as Event." In P. Shepard and Mc Kinley (Eds.), Environ/mental: Essays on the Planet as Home: 61-79, Houghton, NY, 1971.

13- Ayotte, J., I. Peretz, and K. Hyde. "Congenital Amusia." Brain (125.2): 238-251, 2002.

9. SYMBOLS

a scaling factor

c speed of light, m s^{-1}

e wave energy, J

f_s sound frequency (pitch), s^{-1} (Hz)

h Planck's Constant, 6.626×10^{-34} J s

k Photo-Acoustic Number

k' Acousto-Optic Number

k_t Thermo-Optic Number

m, n correlation exponents

M mean value in a regression series

N number of half steps

O octave (starts with note C)

O' octave code (starts with note A)

o replication factor

OF objective function

p no. of data points in a regression series

r reflectance level: perceived tone

R permutation data series identifier

RF regression factor

s order of polynomial

S slope of the regression line

SD standard deviation

T_a absolute air temperature, K

v_s speed of sound, m s^{-1}

X instrument code

Y note played

Z note code

ϕ Golden Ratio $[\sqrt{5}+1]/2 \approx 1.618\ldots$

π Pi Number $\approx 3.14159\ldots$

λ_p, λ_s light, sound wavelengths, m

θ angle of diffraction, radians

Ω_{ps} Simulation Number

10. APPENDICES

Appendix A. State of the Art

Table A-1 is a compilation of a comprehensive literature survey [3]. As this table reveals, there is not any consensus among the color-sound correlations available in the literature and they cover only a limited range of the audible and visible range for humans.

Table A-1. Color-Music Correlation: State of the Art.

AUTHORS	Typical claims with closest number matching wavelength λ_p is in nanometers (nm), note pitch f_s is in s^{-1} (Hertz)						
	Red	Orange		Green	Blue	Indigo	Violet
* Maerz, A., Paul, M	λ_p=627:D#(f_s=622)	592:D (588)	573:C# (554)	523:C (524)	468:A (466)	—	—
Dinshah Health Soc.	f_p=397·10^{12}:G(f_s=392)	431:A (440)	464:A# (466)	531:C (523)	631:F (699)	—	—
** Maistre, R	A	B	C	D	E	F	G
** Mizler, L. C	C	D	E	F	G	A	B
***Castel, L. B.	G	F	E	D	C	B	A
** Sudre, F.	C (do)	D (re)	E (mi)	F (fa)	G (sol)	A (la)	B (si)

* In this row, first numbers are the light wavelengths λ_p in m; numbers in parentheses are the key note sound pitches f_s in s^{-1}.
** Authors did not elaborate on the numerical values of wavelengths and, or frequencies.
*** The author used "yellowish orange" color, instead of orange.

Appendix B. Calculations and Diagram Constructi n

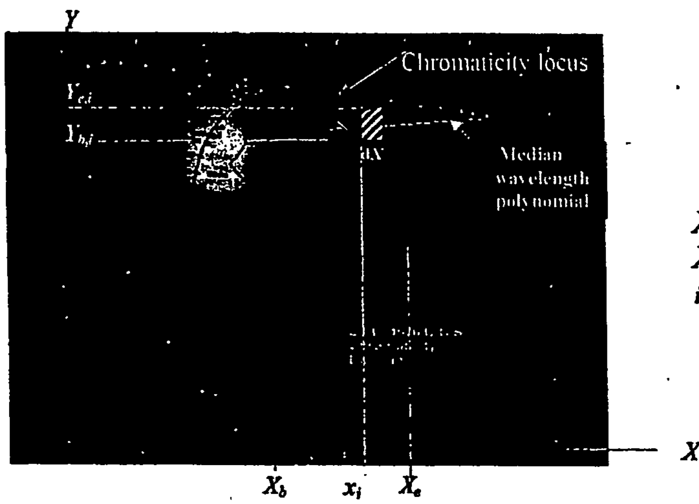
<u>B-1. Median Wavelengths of Pure Spectral Colors:</u> Geometric center of incremental elements drawn in the chromaticity field for each spectral color were fitted with a s^{th} order polynomial.

$$(Y_{e,1}-aX_1^{s}-bX_1^{s-1}\ldots-z)\cancel{dX} \equiv (aX_1^{s}+bX_1^{s-1}\ldots+z-Y_{b,1})\cancel{dX} \qquad \{\text{element } 1, i=1\} \qquad \text{(B1.1)}$$

$$\ldots\ldots$$

$$(Y_{e,s+1}-aX^{s}_{s+1}-bX^{s-1}_{s+1}\ldots-z) \equiv (aX^{s}_{s+1}+bX^{s-1}_{s+1}\ldots+z-Y_{b,s+1}) \qquad \{\text{element } s+1, i=s+1, s\leq 6\} \qquad \text{(B1.s+1)}$$

s+1 simultaneous equations are solved for s+1 unknown coefficients a, b,..z of the polynomial, which intersects the chromaticity locus to give the median wavelength of that spectral color field.



$X_i = x_i + \frac{1}{2}dX$
$X_b \leq x_i \leq X_e$
$i = 1,..s+1$

Figure B-1. Calculation of the Median Wavelength for the Color Red on the Color Chromaticity Diagram [4].

<u>B-2. Exhaustive Search for Optimum Color-Sound Match at the Middle Octave:</u> Order of the spectral colors is fixed by their wavelength sequence. There remain 5,040 (7!) combinations of seven fundamental note sequencing, among which one of them gives a consistent k.

$$(a/r)(\lambda_s^{m}/\lambda_p^{n}) = k \quad \{n = m > 0, 0 < r < 1, k > 0, \lambda_s, \lambda_p > 0\} \quad \text{(B2.1)}$$

Mathematical correlation is based on daylight illumination ($r = 0.5$) at the middle octave. Therefore, at the middle octave a is constant and is equal to 0.5.

Objective Functi n: Two objectives having equal weights must be simultaneously satisfied:

i- Minimum standard deviation SD,

ii- Zero slope S for the regression line for a consistent k value:

$$OF = (p\text{-}1)^{0.5}SD + S \;. \leftarrow \text{MINIMIZE } \{p = 7\} \qquad \text{(B2.2)}$$

Procedure: Two nested loops exhaustively search 5,040 combinations for the minimum OF.

<u>Loop 1</u>: Sequence starts at ABCDEFG (perm. data series R=1), ends at GFEDCBA (R=5,040).

<u>Loop 2:</u> Selects optimum m for the minimum regression factor:

$$RF = \sum_{j=1}^{p} |1 - |(M - y_j)|| \;. \qquad \{m = n\} \qquad \text{(B2.3)}$$

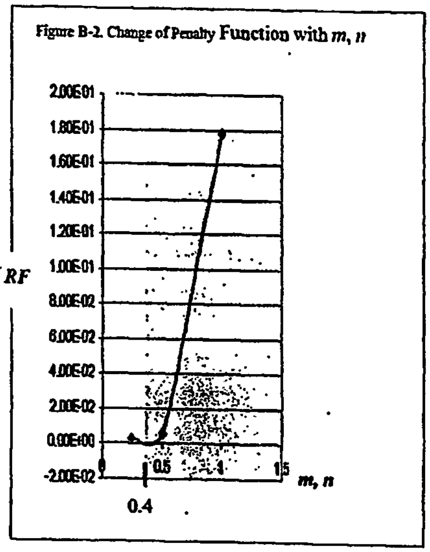


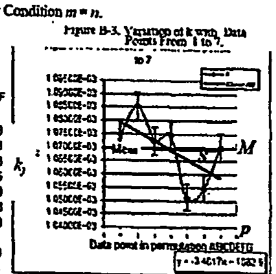
Table B-1. Determination of Optimum m, n, and k. Boundary Condition $m = n$.

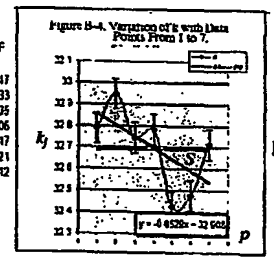
$m = n = 0.5$

Data Point	λ_s	λ_p	$k = (\lambda_s/\lambda_p)^{0.5}$	$[(\lambda_s/\lambda_p)^{0.5}-M]^2$	Penalty, PF
1	7.86E-01	6.80E-07	1.07512E+03	3.63E+01	9.5846E-03
2	7.01E-01	5.95E-07	1.08543E+03	2.67E+02	6.3981E-03
3	6.61E-01	5.75E-07	1.07218E+03	9.52E+00	3.1911E-03
4	5.89E-01	5.10E-07	1.07466E+03	3.10E+01	3.6633E-05
5	5.25E-01	4.75E-07	1.05131E+03	3.16E+02	3.2854E-03
6	4.95E-01	4.45E-07	1.05468E+03	2.08E+02	6.5563E-03
7	4.41E-01	3.85E-07	1.07026E+03	1.36E+00	9.8466E-03
		Mean, M =	1069.092363	SD/M = 0.011	5.5568E-03
					5.683E-03
		Optimum k = 1.07E+03			(when k is rounded to 1070)

$m = n = 0.25$

Data Point	λ_s	λ_p	$k = (\lambda_s/\lambda_p)^{0.25}$	$[(\lambda_s/\lambda_p)^{0.25}-M]^2$	Penalty, PF
1	7.86E-01	6.80E-07	3.2769E+01	8.65E-03	0.004826247
2	7.01E-01	5.95E-07	3.2946E+01	6.24E-02	0.003221333
3	6.61E-01	5.75E-07	3.2744E+01	2.32E-03	0.001611235
4	5.89E-01	5.10E-07	3.2782E+01	7.41E-03	4.07323E-06
5	5.25E-01	4.75E-07	3.2424E+01	7.40E-02	0.001624617
6	4.95E-01	4.45E-07	3.2476E+01	4.84E-02	0.003250421
7	4.41E-01	3.85E-07	3.2715E+01	3.54E-04	0.004881512
		Mean =	32.69653318	SD = 0.0055	2.77E-03





<u>Explanation:</u> y_j is the regression solution for k_j at data point j. M is the arithmetic mean of k_j values from a given regression series. Table B-1 is the ABCDEFG permutation for Figure B-2 to find minimum RF, which occurs at m=0.25. Optimum solution is unfeasible, because accuracy is better than the composite maximum sensitivity of human eye and ear: ½(1/440 Hz/Hz + 5/680 nm/nm) = $4.81\times10^{-3} \geq RF$ @ m= 0.4. $m > 0.43$ if $k \geq 1000\cdot2^{1/12}$. Optimal m is 0.5 for all permutations. $\Delta RF = 1.15\times10^{-4}$.

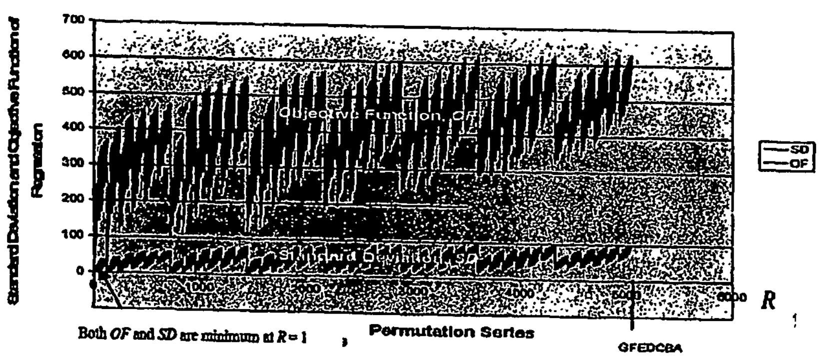


Figure B-5. Variation of SD and OF with 5,040 Permutation Series (O' = 4).

<u>B-3. Construction of the Acousto-Chromatic Diagram:</u> Iso-octave planes were constructed by the logarithmic fit O' = 1/3log(12.6/λ_s), as obtained from associated λ_s values in all octaves for the

color red. This color was selected, because the human eye is most sensitive to it. In order to keep the solutions within the color chromaticity diagram, a linear replication function was derived:

$$\lambda_p = 680\text{-}(680\text{-}385)((12.6/\lambda_s)^o\text{-int}[(12.6/\lambda_s)^o]) \quad \text{(B3.1)}$$

Equation B3.1 is the final step to plot r versus λ_s (Figure B-6.b). A constant replication factor o of 0.581 adjusts the solutions for the non-linearity of the color wavelength spectrum. In Figure B.6-a, z axis is the r axis, x, y axes are the color chromaticity diagram axes u' and v'. Each iso-octave (also iso-reflectance level) plane matches the previous (lower) plane with a projection obtained from Figure B-6.b. This projection generates progressively shrinking chromaticity diagrams. Each plane has its own color chromaticity locus starting from 680 nm and ending at 385 nm. This plane laying process represents the replication of colors. Median wavelength points coincide with the polynomial lines described in Appendix B-1.

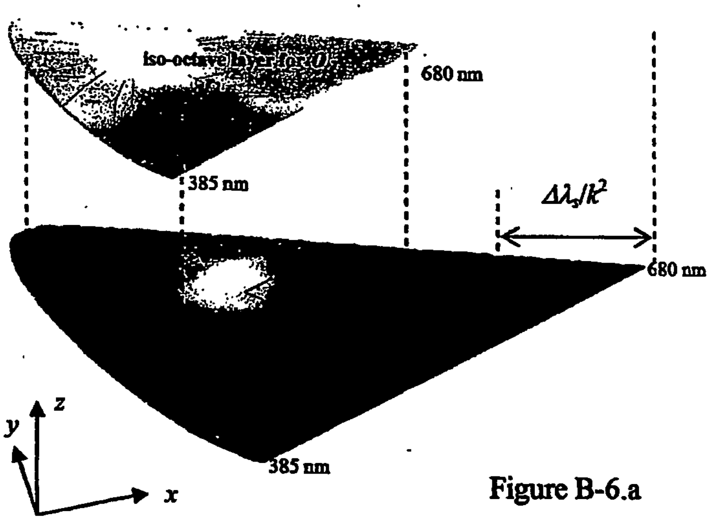


Figure B-6.a

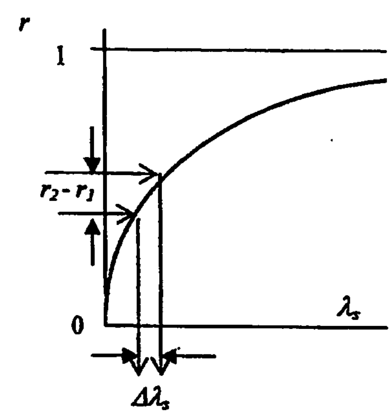


Figure B-6.b

Figure B-6. A Typical Construction Step of the Acousto-Chromatic Diagram.

Appendix C. CMIDI Sequencing and Orchestral Frames of "Our World is a Kaleidoscope"

This appendix is available in my Disclosure Document Numbered 533409

Appendix D. Musical N tation of "Listen to the Water."

This appendix is available in my Disclosure Document Numbered 533409

United States Patent Application
Kind Code
Kilkis, Siir

Siir's Photo-Acoustic Theory and Visual Orchestration Technology

Abstract

Using *Siir's Photo-Acoustic Theory* a continuous mathematical function was derived, which establishes a seamless correlation between color and sound waves in the audible and visible range of human perception. According to this correlation, there is a unique relationship between the wavelengths of color and sound, expressed by the *Photo-Acoustic Number*. This mathematical correlation maps the replication of musical notes in seven octaves of music onto the color chromaticity diagram by establishing a direct correlation between the seven octaves of music and the color tone index defined as the reflectance levels of seven pure spectral colors (Red, Orange, Yellow, Green, Blue, Indigo, Violet: ROYGBIV). The new diagram called *Acousto-Chromatic Diagram* superposes the audible sound on the entire color spectra. Using Siir's Photo-Acoustic Theory, Acousto-Chromatic Diagram, and a new Color-Midi Sequencing Algorithm (*CMIDI*) *Visual Orchestration Technology* (*Music Painter*) was developed, which dynamically colorizes musical compositions simultaneously for all instruments in the orchestra. This Technology dynamically maps each note played by every instrument for every time interval in a measure to the corresponding pure spectral color and its distinct reflectance level. The Visual Orchestration Technology has several attributes, including enhancing music cognition with color, harmonizing music through visual patterns, and enabling orchestration by hearing deficient composers. By reverse engineering the Visual Orchestration Technology, any visual artwork can be transformed into an orchestral arrangement. This technology is called *Art Composer*. In this Technology, any visual artwork is discretized into small fragments (grids). The discretization grid has two dimensions. First one is the time frame that musical notes corresponding to the color in that art fragment plays. The second dimension is the instrument in the orchestra, which plays that art frame. Art Composer enables the visually impaired to listen any artwork and adds a new dimension in composing and interpreting any visual artwork by incorporating the auditory perception. Using the Photo-Acoustic Number with the newly derived *Acousto-Optic Number* and the *Thermo-Optic Number* a compound correlation among light, sound, and heat was established, which can be used to modulate thermal radiation, sound, and light waves.

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Serial No.:
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U.S. Current Class:
U.S. Class at Publication:
Intern'l Class:

Foreign Application Data		
Date	**Code**	**Application Number**

What is Claimed is:

1. A Mathematical correlation called *Siir's Photo-Acoustic Theory*, which establishes a seamless, continuous, and direct correlation between any sound wavelength audible by human ear and any visible light wavelength at any ambient temperature, and medium. This Theory is described in the attached explanation of the patent, and formulated in Equations 1, 2, and 3.
2. Three Theorems of the patent, which are explained in Page 4 of the attached Patent Explanation Document.
3. In Equations, 1,2, and 3 the following variables are claimed as part of this patent:
    a. *Photo-Acoustic Number k*, which associates and proportions any light wave associated with a color at a given reflectance level to any sound wave, or any sound wave to a unique light wave associated with a unique color at a unique reflectance level.
    b. *Reflectance level r* of a light wave that associates with a spectral color.
    c. Reflectance level *r*, which associates with the octave codes of music such that a unique sound corresponds to a unique light wave associated with a color at a unique reflectance level, or any light wave corresponds to a spectral color at a reflectance level to a unique sound wave.
    d. *Adjustment Factor a*, which enables to uniquely map any audible sound to a unique light wave that associates a unique color at a unique reflectance level. The same adjustment factor enables to map any visible light wave that associates with a color at a given reflectance level to a unique audible sound
    e. Adjustment Factor *a*, which makes the correlation between visible light and audible sound waves to be one-to-one (unique) and keeps the correlation within the color-chromaticity diagram.
    f. Adjustment Factor *a*, which maintains the unique correlation between octave codes of music and reflectance level of spectral colors.
    g. *Octave Code O'*, which is defined in Table 4, page 6 of Disclosure Document 533409. Octave Code is an integer number between one and seven. Every note A in all musical octaves starts a new Octave Code, starting from one.
    h. In every Octave Code, all musical notes from A to G are assigned an integer number called *Note Code Z*, which starts from zero and ends at six, as shown in Equation 6 and Table 2 of Disclosure Document 533409.
    i. Any mathematical correlation, which relates light and sound waves with the Golden Ratio, as given in Equations 2 and 3.
    j. Powers of the wavelength *m* and *n*, that uniquely correlate their ratios
4. A Mathematical correlation called *Siir's Photo-Acoustic Theory*, which maps any audible sound wave to a unique visible light wave, which corresponds to a unique associated color at a unique reflectance level.
5. A Mathematical correlation called *Siir's Photo-Acoustic Theory*, which maps any visible light wave, which corresponds to a unique associated color at a unique reflectance level to a unique sound wave audible by human ear.
6. A Mathematical correlation called *Siir's Photo-Acoustic Theory*, which relates octaves in music to reflectance levels (or any other descriptive quality of light waves or colors) of spectral colors.

7. A Mathematical correlation called *Siir's Photo-Acoustic Theory,* which relates reflectance levels (or any other descriptive quality of light waves or colors) of spectral colors to octaves in music.
8. Three Theorems of *Siir's Photo-Acoustic Theory.* These theorems are explained in the attached explanation of the Patent, Equations 1, 2, and 3.
9. An *Acousto-Chromatic Diagram,* which uniquely correlates and embeds all visible light and audible sound waves. This diagram is shown in Figure 1.
10. An *Acousto-Chromatic Diagram,* which shows each Octave Code of music in a specific plane called *Iso-Octave Planes.*
11. An Acousto-Chromatic Diagram, which is constructed with the details given in Appendix B, or any other analytical or geometric method to correlate light and sound waves in their entire ranges.
12. A *Digital Orchestral Seating Chart* as shown in Figure 2-b of the attached Patent Explanation Document.
13. A Mathematical correlation called Siir's Photo-Acoustic Theory, which derives a *Color-Midi Sequence* (*CMIDI*) to associate the MIDI sound Algorithm with spectral colors in a manner described in Claim Number 1. CMIDI Algorithm is explained in page 5, Figure 2, and page 6.
14. Color-Sound Association for White Piano Keys using Siir's Photo-Acoustic Theory as shown in Table 1.
15. Any color-sound association for white piano keys using any correlation, which yields a Table similar to Table 1, or any other graphical illustration, such as but not limited to a slide rule which is illustrated in pages 54, 55, 56, and 57 of the Disclosure Document 533409.
16. Any Color Sound Association for any musical instrument, which yields a Table similar to Table 1, or any other graphical illustration such as but not limited to a slide rule which is illustrated in pages 54, 55, 56, and 57 of the Disclosure Document 533409.
17. Any manual, semi-automatic, automatic, mechanical, electronic tool (like rolodex), or calculator, which represents any color-sound association, and depends on any scientific, physical, mathematical and engineering analysis such as Siir's Photo-Acoustic Theory
18. Any Electronic keyboard or any educational musical instrument or any teaching tool that uses Siir's Photo-Acoustic Theory or other subjects of this Patent and its claims listed herein.
19. *Visual Orchestration Technology "Color Acoustics,"* which colorizes an orchestral music on a real-time or off-line basis, which is based on Siir's Photo Acoustic Theory, as shown in Figure 4, and explained in pages 9, 10, 11, 12, 13, 14.
20. Any technology which colorizes an orchestral music on a real-time or off-line basis similar to or exactly the same way as shown in Figure 4, and explained in pages 9, 10, 11, 12, 13, 14, either based on Siir's Photo Acoustic Theory, or another mathematical correlation.
21. *Art Composer Technology,* which is a reverse engineering of the Visual Orchestration Technology and orchestrates any visual artwork, as explained in pages 14, 15, 16, and 17, and Figures 9 and 10, and Table 2.
22. *Acousto-Optic Number* as explained in pages17, 18, and Equation 7.
23. *Thermo-Optic Number* as explained in page 18 and Equation 8.
24. *Simulation Number* as explained in page 18 and Equation 9.
25. *Rosetta Stone of Light, Sound, and Heat* as explained in page 18 and Figure 10.
26. Any application of the subjects of this patent, its claims and Siir's Photo-Acoustic Theory, its theorems, and its corollary one (Page 18, Equation 9) in any field like medicine, engineering, education, music, military and civil applications, the before-mentioned directly, or indirectly, or in a fashion which is the before-mentioned are implied, or directly adopted. Sample applications of this patent, which are claimed are exhibited in the Attached Patent Explanation Document and the Disclosure Document 533409.
27. A Mathematical correlation called Siir's Photo-Acoustic Theory, which extends in the same manner defined in Claim Number 1 to any light and sound frequency outside the human audible and visible range.

28. A Mathematical correlation called Siir's Photo-Acoustic Theory, which defines a ratio between the wavelengths of light and sound in terms of a non-dimensional ambient temperature dependent number called *Photo-Acoustic Number.*
29. A Mathematical correlation Called Siir's Photo-Acoustic Theory, which categorizes pure spectral colors in terms of their color tones, called *Reflectance Level.*
30. A Color tone index called Reflectance Level, which varies between zero and one and assigns a unique color tone for any pure spectral color in reference to its correlated sound wave.
31. A Mathematical correlation Called Siir's Photo-Acoustic Theory, which assigns a unique pure spectral color to any musical note at any musical octave in the sequence of ROYGBIV and musical note sequence of ABCDEFG.
32. A Mathematical correlation Called Siir's Photo-Acoustic Theory, which numerically identifies each musical note by a new numerical coding system, called the *Octave Code.*
33. An *Octave Code System*, which numerically assigns unique integer numbers to complete sets of replicating musical notes in every octave. *Octave Code* changes from zero to seven and it is an integer number.
34. An *Octave Code System*, which identifies each musical note by a unique integer number ranging from zero to six.
35. A Mathematical correlation called Siir's Photo-Acoustic Theory, which maps the replication of musical notes in seven octaves of music onto the color chromaticity diagram by establishing a direct correlation between the seven octaves of music and the color tone index defined as the reflectance levels of seven pure spectral colors (Red, Orange, Yellow, Green, Blue, Indigo, Violet: ROYGBIV).
36. It is also claimed that, the following names are subject to trademarks:
    i. *Siir's Photo-Acoustic Theory*
    ii. *Photo-Acoustic Number k*
    iii. *Reflectance level r*
    iv. *Adjustment Factor a*
    v. *Octave Code O'*
    vi. *Note Code Z*
    vii. *Acousto-Chromatic Diagram*
    viii. *Iso-Octave Planes*
    ix. *Digital Orchestral Seating Chart*
    x. *Color-Midi Sequence (CMIDI)*
    xi. *Visual Orchestration Technology*
    xii. *Music Painter*
    xiii. *Art Composer Technology*
    xiv. *Acousto-Optic Number*
    xv. *Thermo-Optic Number*
    xvi. *Simulation Number*
    xvii. *Rosetta Stone of Light, Sound, and Heat*
37. Any other claim pertaining to any disclosed information in the attached Patent Explanation Document and Disclosure Document 533409 shall be added in due time.

Description

This patent covers new technologies, algorithms, diagrams, definitions, applications, and applied theories. All these subjects of this patent are described in the attached explanation. Background of the inventions and the description of the related art (state of the art) are also given in this attached document.